change affecting the matter of the brain is all that i needed to set him in motion. May not other beings be capable of touching what we may call the hair-triggers of the universe? Whatever these agencies are, angels or ministering spirits, they certainly do not belong to the present visible universe. The writers examine the sacred records to confirm their speculations.

Thus, then, we have a visible and an invisible universe, and we have processes of delicacy in the former which at least suggest the action on it of agencies belonging to the latter. Let us look at the first phenomenon of the visible universe—the expenditure of energy in it. The sun's energy is issuing in what is apparently waste space just as it is issuing in that portion of space which is filled by our earth. What becomes of the energy—probably far more than half of that which proceeds from it—which proceeds apparently nowhere, speeding on with the velocity of light? Is it absorbed in the ether, and if so, what does the ether do with it? The writers suggest that the ether may preserve for intelligent beings the record of the past. But that seems scarcely sufficient use of the energies spent on it; the more so as the intelligent beings existing in the visible universe will certainly come to an end with it.

"We were led," say the authors, in a passage in which their whole theory is perhaps summed up, "to conclude that the visible system is not the whole universe, but only, it may be, a very small part of it; and that there must be an invisible order of things, which will remain and possess energy when the present system has passed away. Furthermore, we have seen that an argument derived from the beginning rather than the end of things assures us that the invisible universe existed before the visible one. From this we conclude that the invisible universe exists now, and this conclusion will be strengthened when we come to discuss the nature of the invisible universe, and to see that it cannot possibly have been changed into the present, but must exist independently now. It is, moreover, very closely connected with the present system, inasmuch as this may be looked upon as having come into being through its means.

"Thus we are led to believe that there exists now an invisible order of things intimately connected with the present, and capable of acting energetically upon it—for, in truth, the energy of the present system is to be looked upon as originally derived from the invisible universe.

"Now, is it not natural to imagine that a universe of this nature, which we have reason to think exists, and is connected by bonds of energy with the visible universe, is also capable of receiving energy from it? Whether is it more likely that by far the larger portion of the high-class energy of the present universe is travelling outwards into space with an immense velocity, or that it is gradually transferred into an invisible order of things? May we not regard ether or the medium as not merely a bridge between one portion of the visible universe and another, but also as a bridge between one order of things and another, forming as it were a species of cement, in virtue of which the various orders of the universe are welded together and made into one? In fine, what we generally call ether may be not a mere medium, but a medium *plus* the invisible order of things, so that when the motions of the visible universe are transferred into ether, part of them are conveyed as by a bridge into the invisible universe, and are there made use of or stored up. Nay, is it even necessary to retain the conception of a bridge? May we not at once say that when energy is carried from matter into ether it is carried from the visible into the invisible; and that when it is carried from ether to matter it is carried from the invisible into the visible

"If we now turn to thought, we find that, inasmuch as it affects the substance of the present visible universe, it produces a material organ of memory. But the motions which accompany thought will also affect the invisible order of things, and thus it follows, that '*Thought conceived to affect the matter of another universe simultaneously with this may explain a future state*' (see Anagram, NATURE, Oct. 15, 1874)."

Our notice has already extended so far that we shall not follow the authors into their examination of the Scriptures, and of certain Christian hymns in which the sentiments and feelings of the Christian world seem to them to be embalmed. We notice only two of the objections to their system, which they themselves state, and seem to us to fail to refute. It is said that "if energy is transferred from the visible into the invisible universe, its constancy in the present universe can no longer be maintained." The answer is, that this visible universe is not the whole universe, and that the conservation of energy principle is applicable only to the whole universe, visible and invisible together, except under special limitations. The retort is obvious, that in this sense, and except when these special limitations specially and finally remove the difficulty, the principle becomes unintelligible and useless. It is a mere theological dogma to say that what energy perishes in the visible passes into the invisible universe; and the dogma is worthless as a physical principle on which to build any physical reasoning. The other objection is, that the dissipation of energy must go on even in this invisible universe, and the new assumption only delays the inevitable end of all things. The answer made is, that the universe may be regarded as an infinite whole. We have no objection, but the same may be said of the visible universe, and the moment that it is so regarded the arguments on which its end and its beginning are inferred seem to vanish into air. An infinite universe will have an infinite store of energy, and there is no need to suppose that its store is ever exhausted, or that in any finite time it has become practically degraded and unavailable. The whole elaborate machinery of the invisible universe (p. 171), piled one on the top of the other, seems to us to fall like a house of cards, if we can accept the eternal duration of an infinite by-sense-perceptible universe.

The book is written in a simple and persuasive style, with a transparent simplicity and purity of purpose. Once or twice there is an outburst of irrepressible energy, like that on pp. 106 and 107, about wife-beaters, who are to be subjected "by an enlightened Legislature to absolutely indescribable torture, unaccompanied by wound or even bruise, thrilling through every fibre of the frame of such miscreants." But these outbursts are transient, and they relieve the strain on the reader's attention.

THE TIDES OF THE MEDITERRANEAN

Az Arapály Fiumei Obölben (*The Tides in the Roadstead of Fiume*). Prize Essay, published by the Royal Philosophical Society of Hungary. By E. Stahlberger, Professor in the Imperial Royal Marine Academy. (Buda-Pesth, 1874, 4to., pp. 109, with plates and copious tables.)

FEW points in physical geography have had more interest for scientific men than the tides of the Mediterranean. Connected with the Atlantic only by a strait of a few miles in width, this inland sheet of water is so effectually shut off from the general tidal movements of the main ocean, that it has often been called a "tideless sea." But this is not correct; for, having an extent of surface of some 700,000 or 800,000 square miles, it is sufficiently large to be itself specially affected by the attraction of the sun and moon, and thus it possesses a true, although small, tide of its own.

The daily variations in the level of the water have of course been always patent to the dwellers on the Mediterranean coasts; and, no doubt, careful observers must have remarked a periodicity in the recurrence of such variations, identifying them to a certain extent with the ocean tides. But from the small amount of the true periodical rise and fall, and from the large influence of accidental causes, the phenomena have been so irregular as to present great difficulties in their analysis; and, so far as we know, there has not been, down to the appearance of the present work, any systematic investigation of the subject put on record.

The present publication has arisen from a prize of 200*l.* having been offered in 1872 by the Royal Hungarian Society (from funds furnished by Government) for scientific labours bearing on the physical or meteorological conditions of the kingdom of Hungary.

Fiume is a town of some importance, lying on what is called the Hungarian *littorale*, washed by the waters of the Gulf of Quarnero, an irrregular-shaped recess in the extreme north-eastern part of the Adriatic. The Government of Hungary, desirous to promote the maritime interests attached to their little seaport, have established there a Marine Academy, and M. Stahlberger, one of the professors in that institution, had had occasion to make and register observations on the rise and fall of the water in the neighbouring roadstead. Conceiving that by studious labour the phenomena he had recorded might be reduced to something like rule and order, he undertook the elaborate theoretical discussion of them, and the Society, appreciating the value of the work, has not only awarded him the prize for it, but has published it, in full detail, for the benefit of science in general.

The author was led to this investigation by the double object of obtaining accurate information, first, as to the general phenomena of the tides in the Adriatic, or rather in the Mediterranean generally; and secondly, as to the peculiarities in these phenomena induced by local influences in the neighbourhood of the port of Fiume.

He remarks, in regard to the first point, that the semi-mensual irregularity which it is customary to deduce from observations, in order to predict the times of high and low water, is altogether different in the Adriatic from what obtains in regard to the ocean generally; and yet the causes of this difference have never yet been explained.

In regard to the second point, he refers to notices that had appeared of remarkable irregularities in the Fiume tides, which rendered further investigation very desirable. It had been perceived, that instead of the usual six hours' alternating ebb and flow, there was frequently only one high and one low water in the day; and, moreover, that the time of the lowest water advanced on the average two hours every month, or twenty-four hours in a year.

These strange phenomena had attracted attention, and in 1868 the Adria Commission of the Imperial Academy of Sciences at Vienna established a self-registering tide-gauge at Fiume, the control of which was entrusted to M. Stahlberger. The present essay contains the results of three years' observations, which are fully and scientifically discussed by him.

The tide-gauge was on a plan that has often been used in this country. It consisted of a float, which by means of connecting machinery and a pencil made a mark on a sheet of paper stretched on a drum. The drum being moved uniformly by clockwork so as to make one revolution in twenty-four hours, the height of the tide at any time of the day could be deduced by simple measurement from the curve produced on the paper. The same paper was used for three days' observations, the curves being distinguished from each other by different coloured pencils being attached at the beginning of each day.

The author appears to have gone to work in his investigation in a thoroughly philosophical way. He has first collected a very large number of facts, as shown by the records of his gauge; he has then tabulated them with great care and ingenuity, classifying them with special reference to the nature of the influences known to be in operation, such as the positions of the heavenly bodies, the direction and force of the wind, the state of the barometer, and so on; and finally, working on the records thus arranged, he has, by applying scientific calculations of a high order, been able to a large extent to simplify the complicated questions involved, and to throw much light on their explanation.

To facilitate the investigation, he divides the tidal phenomena into two classes: namely, in the first place, periodical motions of the water produced by cosmical causes; and secondly, non-periodical motions produced by the influence of meteorological or local agencies. He then discusses each of these two divisions at considerable length.

As to the periodical motions, he found that in calm weather, and even to a less extent at unsettled times, the figures drawn by the gauge showed unmistakable signs of periodicity; but the appearances were of two kinds: sometimes they showed two well-defined maxima and minima, six hours apart; at other times there was only a single maximum and minimum, sharply defined, these two types melting into each other with all gradations.

These regular forms were clearly to be referred to the periodical motions of the heavenly bodies, and the author, having carefully collected and arranged the facts, enters into a long and full theoretical discussion of their causes, according to the principles laid down by Newton and Laplace.

We cannot pretend to give any details of the laborious mathematical calculations which follow: it must suffice to extract the author's brief summary of his results on this head. He says that the periodical movements of the sea in the Gulf of Fiume depend in the first place on four simple oscillations, two of the sun and two of the moon; and secondly, on four other simple vibrations, two due to each body, which are reckoned in sidereal time, but which have only a slight effect, and may be neglected in computation.

If δ_m and δ_s represent the declinations of the moon and sun respectively, ρ_m and ρ their distances (expressed in terms of their respective mean distances), t_m and t_s the numb of lunar or solar hours (Mondbeziehungsweise Sonnenstunden) which have elapsed since the last upper culmination of either body respectively; then the theoretical elevation or depression of the sea in the Gulf of Fiume due to these causes for any given time is found in millimetres by the expression:—

$$112{\cdot}1\ \frac{\cos^2\delta_m}{\rho_m{}^3}\cos\frac{\pi}{6}\,(t_m - 8{\cdot}49)$$
$$+\ 272{\cdot}4\,\frac{\sin 2\delta_m}{\rho_m{}^3}\ \cos\frac{\pi}{12}(t_m - 4{\cdot}60) + 60{\cdot}3\,\frac{\cos^2\delta_s}{\rho_s{}^3}\cos\frac{\pi}{6}\,(t_s - 8{\cdot}57)$$
$$+\ 130{\cdot}4\ \frac{\sin 2\delta_s}{\rho_s}\cos\ \frac{\pi}{12}(t_s - 4{\cdot}46)$$

This is the theoretical amount, not allowing for any local retardation, or any influence of the weather.

The author has calculated this for a great variety of conditions of the variable quantities, and compared them with the results of observations, and the comparisons have always been satisfactory.

He gives comparative pairs of curves, one drawn by the tide-gauge, the other calculated by the formula, and the striking resemblance is at once appreciable by the eye. The coincidence would be still nearer if the influence of the small sidereal-time variations were added.

The mean amplitudes of the four chief oscillations are as follows:—

	Millimetres.
For the oscillation of twelve lunar hours ...	103·2
For that of twelve solar hours	55·
For that of twenty-four lunar hours	130·5
For that of twenty-four solar hours	62·4

The maximum amplitudes are:—

For the oscillation of twelve lunar hours ...	132·8
For that of twelve solar hours	60·9
For that of twenty-four lunar hours	272·2
For that of twenty-four solar hours	100·2

The author shows how the variable combinations of these several elements determine and account for the peculiar phenomena observed, and he explains in what particulars the circumstances at Fiume would appear to differ from those in other places, and to give rise to special phenomena peculiar to that locality.

He further devotes particular attention to the explanation of the singular daily retardation, which he states has also been noticed by M. Aimé on the coast of Algeria, although it had been erroneously ascribed by him to the effect of the wind. The real cause he shows to be the oscillations depending on sidereal time.

The non-periodical motions of the water are caused chiefly by variations in the direction and force of the wind, and in the barometer-pressure. The temperature of the sea rain, and storms, may have also some influence, but too slight to require investigation.

The author therefore confines his attention to the wind and the pressure of the air. In regard to the former, looking at the form and position of the Gulf of Quarnero, it is evident that southerly winds will force the water into the cul-de-sac towards Fiume, and so will raise the level, while northerly winds will tend to drive the water out of the gulf, and so lower the surface.

In regard to the barometer-pressure, it is pointed out that if the weight of the atmosphere at any given part of the sea differs from that at another part some distance away, there must be a corresponding difference in the level of the water; and this difference will be proportional to the specific gravities of the two fluids:—thus a difference in the barometer of one inch of mercury will cause a difference of level of about 13½ inches in the water.

The effects of these two influences are involved in various complications, but they are sufficiently proved by the records, and their amount is shown to be considerable.

The following facts shown in the records will give some general idea of the extent of the Mediterranean tides; we believe they are pretty much the same in all parts of the sea.

The highest water level known was on Dec. 26, 1870, being 0·870 metres above a certain datum point; the lowest was on Jan. 11, 1869, being 0·482 metres below the same point. Hence the greatest difference of level experienced was 1·352 metres, or about 4½ English feet.

The average daily variation of level was 0·583 metres, or nearly two feet English; the greatest daily variation was 0·825, and the least 0·259 metres.

The mean daily variation of level is the same, whatever be the absolute general level of the water; as is natural, seeing that the latter is influenced by local circumstances that have no effect on the attractions of the sun and moon.

The mean high and mean low water stand at equal distances above and below the average mean level.

The author modestly expresses the opinion that his own three years' observations are of too limited extent to determine fully the values of all the influences which affect the tides, and he recommends that before the investigation is carried further, accurate observations should be made at other points of the Adriatic Sea, in order that, by a combination of such data, the distinction between normal and exceptional phenomena may be more positively defined. No doubt such an extended inquiry would give results of great value to physical science, and M. Stahlberger's excellent example is not unlikely to stimulate others to co-operate in such an undertaking.

The book is well got up. It is written in the national language, but there is also given a translation into German, and the data, in the form of tables, are so full and complete as to enable anyone to verify, by his own examination, the conclusions arrived at by the author.

OUR BOOK SHELF

Cambridgeshire Geology; a Sketch for the use of Students. By T. G. Bonney, F.G.S., Tutor and Lecturer in Natural Science, St. John's College. Cambridge: Deighton, Bell, and Co., 1875.)

MR. BONNEY'S short sketch of the geology of the neighbourhood of Cambridge will be a useful handbook to those students who wish to become practically acquainted with the geological features of the country round their temporary home. It makes no pretensions to be an exhaustive description, and happily is not written in a style suitable for cramming, but simply draws the attention of the careful reader to all the interesting points in connection with the geology of the district, and notices the various contributions to fact or theory made by previous writers, embodying many of Mr. Bonney's own observations. The first deposits described are the Oxford clay of St. Ives and the Elsworth rock, the true position of which latter is discussed; and then follows a notice of